(328)

Interaction of Guided Waves with Cracks in an Embedded Multilayered Anisotropic Plate by Using a Boundary Element Approach

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In this work, the interaction of a transient guided elastic wave with a planar crack is studied by using a Boundary Finite Element approach on the crack. The originality of this work is to use the numerical Green functions of the multilayered plate. So, the key point of the method is to calculate rapidly and accurately these Green functions for such complex plane structures. For the space variables related to the plate surface, the fields are transformed in the 2D Fourier associated to the wave-vectors on this surface, and they are expressed in the partial-wave basis [1]. To ensure causality, the time dependence is dealt with in the Laplace domain.

Surprisingly, this method, that involves 2D Fourier transform on the surface coupled with Laplace transform, has been rarely used in the ultrasonic community, while it is a useful tool which complements the much used technique based on generalized Lamb wave decomposition. By avoiding mode analysis, which can be problematic in some cases, exact numerical calculations of Green functions can be made in a relatively short time for immersed plates made of a stack of anisotropic viscoelastic layers. Even for 3D cases, numerical costs are relatively low. Numerical results show the effectiveness of this method. The examples presented emphasize the quality of the model and the robustness of the algorithm. Comparisons with Finite Element show excellent agreement. This approach is fast and low memory consuming for planar defects in arbitrary layered media, and can be extended to arbitrary shapes and boundary conditions for, of course, a higher computational cost. It is valid in 3D, however only the 2D case is considered in this work.

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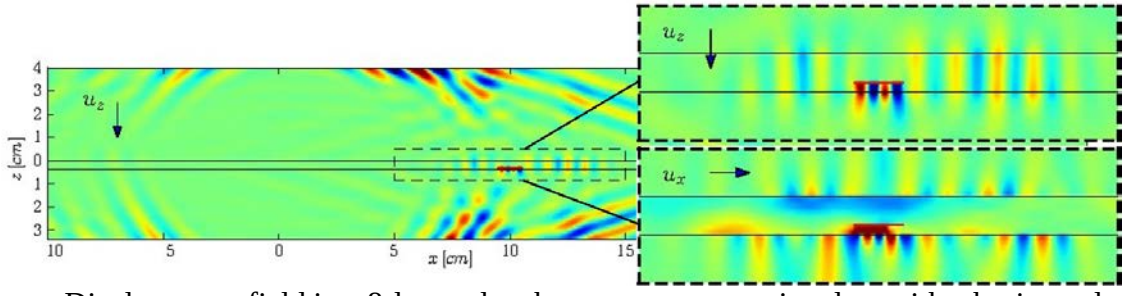

Displacement field in a 8-layered carbon-epoxy composite plate with a horizontal crack

References:

1. Mora P., Ducasse E., Deschamps M., Transient 3D elastodynamic field in an embedded multilayered anisotropic plate, *Ultrasonics* **69** (2016) 106-115, http://dx.doi.org/10.1016/j.ultras.2016.03.020.